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PLANT GROWTH REGULATORS

Preparation and Plant Growth-Regulating Activity of Crude Protein Hydrolyzate Derivatives of DL-2-(2,4-Dichlorophenoxy)-propionic Acid

THIS STUDY is a continuation of research on amino acid amides of plant growth-regulating acids which has been concerned with basic studies on specific purified amino acid derivatives (3-6, 7). The objective of the present work

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was to modify advantageously the growth-regulating properties of conventional, regulating compounds utilizing readily available, inexpensive mixtures of amino acids and peptides. These mixtures come from the simple acid, alkaline, or enzymatic hydrolysis of abundant proteins.

Previous preliminary findings with amino acid amides have shown that

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amino acid coupling with phenoxy-type regulators produces from little or no effect to marked effect upon various growth-regulating properties of this type of compound. On selected test plants this effect depends upon the kind and optical configuration of the amino acid and the kind of phenoxy acid coupled. It also depends upon the specific plant used.

These investigations were undertaken for the purpose of utilizing low-cost protein hydrolyzates made from by-products or readily obtainable protein source materials. DL-2-(2,4-dichlorophenoxy)propionic acid [2-(2,4-DP)], a very active plant growth regulator, was chemically combined with a variety of these materials to determine whether the new products possessed growth-regulating properties that differed qualitatively or quantitatively from the parent acid. In general, coupling of protein hydrolyzates with 2-(2,4-DP) produced derivatives which induced growth responses suggesting the possible commercial use of the former as agents for the preparation of low-volatile amide herbicides. Although the general responses of test plants were somewhat less, corn and cucumber responses were greater, than to the parent acid. Reduction of undesirable formative effects characteristic of phenoxy parent acids may be of interest for other purposes such as induction of fruit development.

Test plants treated with amino acid derivatives of DL-2-(2,4-dichlorophenoxy)propionic acid [2-(2,4-DP)], show wider variability in response than do phenoxy derivatives of other series evaluated. This fact was responsible for the selection of 2-(2,4-DP) for coupling with crude protein hydrolyzate mixtures.

Gentner and Shaw (2) have reported favorably on the selective herbicidal properties of two protein hydrolyzates (A. E. Staley Manufacturing Co., Decatur, Ill.) derivatives of 2-(2,4-DP) prepared by one of the authors. In field tests on 26 crop plants and seven weed species, one of these hydrolyzate derivative products, applied as pre-emergence treatment, was active on small seeded legumes. Both protein hydrolyzate products applied as postemergence sprays showed excellent selective killing activity upon pigweed, mustard, lambsquarters, and broadleaf weeds, with little or no effect on desirable plants such as corn, oats, peanuts, gladiolus, and Sansevieria. These tests, together with those reported here, indicate the practical value of protein hydrolyzate derivative products made from the phenoxy, and possibly other types of plant growth regulators.

Some commercially available protein hydrolyzate mixtures (Hercules Co., Huron Milling Division, Harbor Beach, Mich.) having a known amino acid content were used. In general, these hydrolyzates had been prepared by acid hydrolysis of wheat protein followed by various refinements to yield products with varying amino acid compositions and special flavor characteristics for edible purposes. Composition data on these materials are presented in Table I.

Another group of hydrolyzates (Chemical Concentrates, Division of Baker Industries, Inc., Fort Washington, Pa.) from six protein source materials was used, but the approximate amino acid composition of each of the samples was not determined. Indication of the amino acid content of each protein hydrolyzed is available in the literature (7, 7). The preparation of these hydrolyzates involved an alkaline (lime) treatment carried out under pressure for various time intervals. Hydrolyzate

samples of α -protein from soybean, animal blood, casein, chicken feathers, animal glue, and meat and bone meal were supplied. The purpose in varying the hydrolysis time was to find out if an effect of partial hydrolysis of the protein might be detected in the biological response of test plants. Data on these hydrolyzates are presented in Table II.

For the preparation of the crude protein hydrolyzate derivatives of 2-(2,4-DP) procedures similar to those previously described were employed (3-5). The preparation of the intermediate, DL-2-(2,4-dichlorophenoxy)propionyl chloride, has been described (3). The following description using the protein hydrolyzate HMD-106-B-79 made from wheat is illustrative of the general procedure employed in the preparation of all the protein hydrolyzate 2-(2,4-DP) derivatives.

Preparation of Crude Protein Hydrolyzate Derivatives of 2-(2,4-DP)

To 4.88 grams (0.04M, calculated on a combining weight of 122 from the amino acid composition) of protein hydrolyzate dissolved in 120 ml. of 1N sodium hydroxide (0.12M) and chilled to 5° C. were added dropwise with stirring 30 ml. of a benzene solution containing 10.0 grams (0.04M) of DL-2-(2,4-dichlorophenoxy)propionyl chloride. After 1 hour, the cold mixture was allowed to warm up to room temperature and then extracted three times with diethyl ether (120-, 40-, and 40-ml. portions). The ether extracts were combined and washed once with water, and the water washing was added to the extracted alkaline aqueous solution. To the latter, during mechanical stirring, sufficient 1N hydrochloric acid was added to adjust the alkaline solution to a pH of 2. A brown oily product separated, which became somewhat crystalline after overnight storage in the refrigerator. The supernatant liquid was discarded and the product washed thoroughly with several portions of water. After being dried to constant weight in a vacuum desiccator, the product was thoroughly washed with portions of hot petroleum ether (63° to

70° C.) to remove traces of parent acid. The weight of the vacuum-dried product was 10.88 grams, 78.4% yield. Analytical data on this and other final products prepared from the various wheat gluten hydrolyzates are presented in Table I.

In the preparation of 2-(2,4-DP) derivatives of the hydrolyzates from the crude proteins listed in Table II, techniques similar to those described above were used. To estimate the quantity of 2-(2,4-dichlorophenoxy)propionyl chloride required for a prescribed amount of hydrolyzate solution, it was necessary to assume an average combining weight for the amino acids and peptides present in these hydrolyzates; the value assigned was 120. An average of 33.3% solids [solids less calcium chloride (see Table II)] and an excess of 80% were used to calculate the quantity of hydrolyzate solution to be used for each reaction. The 80% excess was an attempt to adjust for the impurities present in the crude proteins hydrolyzed. In retrospect, this figure appears to have been slightly low in several cases, as indicated by a nitrogen value of 8.44% for the meat and bone meal obtained at a later date.

Discussion of the Chemistry

If the plant growth regulator portion of each product is derived from 2-(2,4-DP) and the latter combines only with amino acids containing one nitrogen atom, then the ratio of chlorine to nitrogen atoms should have an expected value of 2. A small allowance for deviation above this ratio could be made for the possibility of acetylation of the hydroxyl groups of the hydroxy amino acids present, such as hydroxyproline, serine, threonine, and tyrosine. However, the presence of partially hydrolyzed protein in the form of peptide units, multiple nitrogen amino acids, such as arginine, cystine, histidine, and lysine, and the presence of tertiary cyclic nitrogen compounds such as histidine are factors tending to lower the chlorine-nitrogen ratio, apparently restricting the acceptability limit to a maximum of 2. If values higher than 2 for the ratio of chlorine to

Table I. Percentage Composition of Acid-Hydrolyzed Vegetable Proteins^a and Analytical Data on Their DL-2-(2,4-Dichlorophenoxy)propionic Acid Derivatives

Description	Protein Hydrolyzates									
	5-SD Tan powder	HVP-A Tan powder	Luxor Light colored paste	Dee-S Brown paste	HMD-106-B-79 Tan powder	E-610 Brown liquid	L-625 Amber liquid	700 Heavy brown liquid	HMD-105-B-78 Brown paste	
Alanine	3.70	3.70	3.45	3.77	2.50	0.67	1.68	2.79	6.40	
Arginine	2.78	2.78	2.60	2.84	...	0.81	1.27	2.10	...	
Aspartic acid	1.10	1.10	1.03	1.13	...	1.24	0.50	0.83	...	
Cystine	...	...	...	...	...	0.30	Trace	...	...
Glutamic acid ^b	3.14	3.14	2.94	3.21	0.20	1.43	1.43	2.37	0.60	
Glycine	6.66	6.66	6.62	6.81	3.00	0.97	3.04	5.03	7.60	
Histidine	1.54	1.54	1.44	1.57	...	0.40	0.70	...	...
Leucine and isoleucine	...	...	...	...	21.00	0.80	Trace	...	...
Lysine	0.96	0.96	0.90	0.98	...	0.44	0.44	0.73	...	
Methionine	...	...	...	...	3.60	0.27	Trace	...	...
Phenylalanine	3.46	3.46	3.24	3.54	21.00	1.58	1.57	2.61	...	
Proline	7.41	7.41	6.92	7.56	22.00	3.93	3.36	5.58	55.80	
Serine	...	...	...	...	7.50	1.51	...	...	18.60
Threonine	2.01	2.01	1.89	2.06	4.40	0.81	0.92	1.52	11.00	
Tyrosine	...	...	...	...	...	0.38	Trace	...	...
Valine	2.50	2.50	2.34	2.56	10.00	0.84	1.14	1.89	...	
Solids	...	...	88.00	88.00	...	38.00	38.00	52.00	...
Chlorides	52.1	53.8	45.0	41.0	...	17.5	17.5	17.0	...	
Combining weight of amino acid	113.8	113.8	114.2	113.8	122.0	122.2	114.6	112.3	109.1	
Derivatives										
Yield, %	73.1	15.3	40.8	5.4	78.4	21.0	23.0	38.7	33.6	
Chlorine ^c										
Calcd.	21.43	21.43	21.40	21.43	20.91	21.00	21.39	21.53	21.74	
Found	22.91	21.71	19.93	22.40	20.55	21.03	21.49	19.88	21.18	
Nitrogen ^c										
Calcd.	4.23	4.23	4.22	4.23	4.12	4.13	4.22	4.25	4.28	
Found	3.56	4.46	3.88	4.25	3.49	4.96	4.40	3.74	3.69	
Molecular weight										
Calcd. (average)	331.9	331.9	332.3	331.9	340.1	340.3	332.7	330.5	327.2	
Found	310.0	327.0	355.8	316.6	345.1	337.2	330.0	356.7	335.0	
[α] _D ²⁵ (pyridine) ^c	Levo 10	...	Levo 13.6 ± 0.5	...	Levo 14.7 ± 0.5	...	Levo 18.2 ± 0.7	...	Levo 21.5 ± 1.5	

^a Data supplied by Hercules' Huron Milling Division. ^b As monosodium glutamate. ^c Analyses by J. S. Ard.

Table II. Analytical Data on Alkali-Hydrolyzed Proteins and Their DL-2-(2,4-Dichlorophenoxy)propionic Acid Derivatives

Protein Source	Hydrolysis Time, Hours	Sp. Gr.	Hydrolyzate Solutions ^a						Derivative-Mixtures, DM					Residues from Petroleum Ether Extraction of DM	
			pH	Solids, %	Ash, %	Calcium Chloride %	Amount Used, ^b Grams	Product Weight, Grams	Cl, ^c %	N, ^c %	Average molecular weight	Cl/N Ratio	Weight, grams	N, ^c %	
α-Protein, soy	2	1.205	7.10	43.5	9.0	10	50	4.44	14.36	8.10	494	0.70	0.94	0.68	
	4	1.210	7.00	43.5	9.0	9	50	10.87 ^d	17.58	6.26	403	1.11	7.24	0.30	
	8	1.210	7.10	43.5	9.0	8	50	13.24	17.00	6.45	417	1.04	7.49	0.53	
Animal blood	2	1.210	7.15	42.0	12.4	10	25	4.47	15.03	8.26	472	0.75			
	4	1.210	6.90	43.0	12.4	10	25	5.49	17.86	6.63	397	0.72			
	8	1.210	7.00	42.0	13.0	10	25	1.91	18.42	6.39	385	1.06			
Casein	2	1.210	7.20	44.0	11.0	10	50	11.67	16.09	6.93	441	0.92	4.81	0.12	
	4	1.210	7.30	44.0	11.0	10	50	14.65	17.55	6.01	404	1.15	3.14	0.20	
	8	1.210	7.25	44.0	11.0	9	50	12.48	16.50	6.50	430	1.00	6.31	0.32	
Chicken feathers	2	1.210	7.15	46.0	10.0	10	25	2.47	13.68	8.77	518	0.62			
	4	1.210	7.15	45.0	10.5	10	25	2.90	14.15	8.08	501	0.69			
	8	1.210	7.10	46.0	10.5	9	25	3.77	14.69	7.72	483	0.75			
Animal glue	2	1.210	7.00	41.0	12.0	9	75	18.69 ^e	20.93	5.00	339	1.65	7.76	0.42	
	4	1.210	7.10	41.0	12.0	10	75	6.12 ^f	20.31	5.64	349	1.42	3.26	0.96	
	8	1.210	7.10	40.0	10.4	10	75	15.42	17.78	6.93	399	1.01	7.08	0.40	
Meat and bone meal	2	1.210	7.10	41.0	10.5	10	75	11.11	19.54	5.44	363	1.42	7.11	0.39	
	4	1.210	7.10	41.0	10.5	10	75	4.01	19.94	4.83	356	1.63	4.14	0.84	

^a Data supplied by Baker Industries' Chemical Concentrates, Inc.

^b Represents an 80% excess. Ten grams of 2-(2,4-dichlorophenoxy)propionyl chloride used for every 25 grams of hydrolyzate solution.

^c Analyses by J. S. Ard.

Optical rotation ^d Levo 6.0. ^e Levo 3.0. ^f Levo 3.3.

nitrogen were obtained, it was assumed that the product was contaminated with parent acid, 2-(2,4-DP). Further extraction with petroleum ether was indicated for such products and this was repeated until the ratio was satisfactory or remained unaltered by such treatment.

In a few cases the petroleum ether extracted material was spot-checked by

nitrogen analysis to determine if this solvent was extracting the product excessively. Low nitrogen values (Table II) indicate that this was not the case.

From the chlorine-nitrogen ratios and the average molecular weights of the products prepared from proteins hydrolyzed by alkali it is apparent that complete hydrolysis did not occur. It

was approached only in the case of animal glue and the meat and bone meal proteins (Table II). Apparently the resulting mixtures of derivatives may have contained, besides monoamides of the amino acids, some diamide (or polyamide), and ester derivatives, also possibly some purinelike units. In contrast to hydrolysis by acids and enzymes

Table III. Plant Growth-Regulating Activity of Some DL-2(2,4-Dichlorophenoxy)propionic Acid Derivatives of Various Crude Protein Hydrolyzates Tested at 1 or 0.1% Concentrations^a

Products Tested, Listed by Protein Source of 2-(2,4-DP) Derivatives	Protein Hydro- lyzed, Hours	Lanolin Paste Method																								Coated Sand Method			
		Stem Curvature			Growth Inhibition			Epinasty			Formative Effects			Cell Proliferation						Stem Curvature		Growth Inhibition							
		Be	S	Cu	Be	S	Cu	Be	S	Cu	Be	S	Cu	1st Internode			Hypocotyl			Treated Area			B	Cn	B	Cn			
														Be	S	Cu	Be	S	Cu	Be	S	Cu					Be	S	Cu
Parent acid, 2-(2,4-DP)		2 ^b	1 ^b	0 ^b	2 ^b	2 ^b	3 ^b	0 ^b	0 ^b	0 ^b	0 ^b	1 ^b	2 ^b	0 ^b	0 ^b	0 ^b	0 ^b	1 ^b	0 ^b	0 ^b	1 ^b	0 ^b	3 ^b	1 ^b	0 ^b	2	1	3	1
α -Protein, soy	2	3	2	2 ^b	3	3	2 ^b	0	0	0 ^b	0	1	0 ^b	1	1	0 ^b	2	0	1 ^b	2	2	1 ^b	2	2	1 ^b	0	1	0	2
	4	3	3	3 ^b	3	3	3 ^b	0	2	1 ^b	0 ^b	1	1 ^b	3	2	0 ^b	3	2	0 ^b	3	2	0 ^b	3	2	0 ^b	0	1	0	2
	8	3	2	1 ^b	3	3	1 ^b	0	1	0 ^b	0	1	0 ^b	2	2	0 ^b	3	0	1 ^b	3	0	1 ^b	3	2	1 ^b	0	0	0	2
Animal blood	2	1	2	3 ^b	2	3	3 ^b	0	0	0 ^b	0	3	1 ^b	0	0 ^b	0 ^b	1	3	0 ^b	3	3	1 ^b	3	3	1 ^b	0	0	0	2
	4	2	2	1	2	3	3	0	0	3	0	3	0	1	0	0	2	3	0	3	3	3	3	3	3	0	0	0	2
	8	3	1	2 ^b	3	3	2 ^b	0	0	0 ^b	0	2	0 ^b	2	3	0	2	1	0 ^b	3	3	0 ^b	3	3	0 ^b	0	1	0	2
Casein	2	3	2	1	3	3	1 ^b	0	1	0	0 ^b	1	0 ^b	3	3	0 ^b	1	3	0 ^b	2	3	0 ^b	3	3	0 ^b	0	1	0	2
	4	3	1	2 ^b	3	3	2 ^b	0	0	0 ^b	0	2	0 ^b	3	0	0 ^b	2	1	0 ^b	3	1	1 ^b	3	2	1 ^b	0	1	0	2
	8	3	1	1 ^b	3	3	1 ^b	0	3	0 ^b	0	1	1 ^b	3	2	0 ^b	1	2	1 ^b	3	2	2 ^b	3	2	2 ^b	0	1	0	2
Chicken feathers	2	1	2	2	2	3	2	0	0	3	0	3	0	0	0	0	1	3	1	3	3	1	3	3	1	0	1	0	2
	4	1	2	3	2	3	3	0	0	3	0	3	0	0	0	0	1	3	0	3	3	2	3	2	0	0	1	0	2
	8	1	2	3	2	3	3	0	0	3	0	3	0	0	0	0	3	3	0	3	3	3	3	2	2	2	0	0	2
Animal glue	2	3	2	2	3	3	2 ^b	0	1	0 ^b	0	1	0 ^b	3	2	0 ^b	3	1	1 ^b	3	2	1 ^b	3	2	1 ^b	0	1	2	3
	4	3	2	3	3	2	3 ^b	0	0	0 ^b	0	1	0 ^b	2	2	0 ^b	3	2	1 ^b	3	1	1 ^b	3	1	1 ^b	0	1	0	2
	8	3	2	2 ^b	3	3	2 ^b	0	2	0 ^b	0	1	0 ^b	3	2	0 ^b	2	1	0 ^b	3	1	0 ^b	3	1	0 ^b	0	1	1	2
Meat and bone meal	4	2	1	2 ^b	3	3	2 ^b	0	0	3 ^b	0	2	0 ^b	2	0	0 ^b	1	1	2 ^b	2	1	2 ^b	2	1	2 ^b	0	2	0	2
	8	3	2	1 ^b	3	3	1 ^b	0	0	0 ^b	0	1	0 ^b	3	0	0 ^b	1	1	1 ^b	2	1	1 ^b	2	1	1 ^b	0	1	2	2
Vegetable 5-SD	3	1 ^b	0 ^b	3	3	2 ^b	0	0 ^b	0 ^b	0	1 ^b	0 ^b	2	1 ^b	0 ^b	2	1 ^b	0 ^b	2	2	0 ^b	2	0 ^b	2 ^b	0	0	1	2	
HVP-A	2	0	0 ^b	2	3	3	0	0	0 ^b	0	1	0 ^b	0	0	1 ^b	0	0	0 ^b	2	0	0 ^b	2	0	0 ^b	0	0	0	3	
Luxor	2	3	2	3	2	3	0	0	3	0 ^b	0	0 ^b	3	1	0	2	1	0	3	1	0	3	1	0	0	2	1	3	
Dee-S	2	1	0	3	2	3	0	0	0	0 ^b	1	0 ^b	3	1	0	0	1	0	3	1	0	3	1	0	0	1	0	2	
HMD-106-B-79	2	1	1	3	3	3	0	1	1	0 ^b	1	0 ^b	3	2	0	3	1	0	3	2	0	3	2	0	0	1	1	2	
E-610	2	2	1	3	2	3	0	0	3	0 ^b	3	0 ^b	3	3	0	2	1	1	3	2	1	3	2	1	0	0	2	1	
L-625	3	2	0	3	3	3	0	0	1	0 ^b	3	0 ^b	3	3	0	3	1	0	3	2	0	3	2	0	0	0	1	2	
700	2	3	1	3	3	3	0	1	1	0 ^b	3	0 ^b	3	1	0	3	1	0	3	1	0	3	1	0	0	0	0	2	
HMD-105-B-78	2	3	3 ^b	3	3	3 ^b	0	0	1 ^b	0 ^b	2	0 ^b	3	3	1 ^b	2	3	1 ^b	3	3	0 ^b	3	3	0 ^b	0	1	1	2	

^a Test plants designated as follows: Be, bean; S, sunflower; Cu, cucumber; B, barley; and Cn, corn. Activity designated as 0, no effect; 1, slight effect; 2, moderate effect; and 3, marked effect. Observations made 14 days following application of a mixture of one part Tween 20 and four parts lanolin, this mixture contains 1 or 0.1% of the compound.

^b Designates that the responses obtained with a mixture containing 1% of the compound was so marked that evaluation of responses listed could not be made and it was necessary to retest the compound at 0.1% concentration.

(enzymically hydrolyzed protein derivatives have been prepared and are being evaluated), alkaline hydrolysis may have racemized many of the L-type asymmetries to give proportions of D-isomers approaching the 1 to 1 DL-limit. Judging by the low order of activity usually found for the isolated D-isomers (3-5), the expected effect of racemization would be to reduce activity.

Some of the hydrolyzates were unique in composition with especially high proportions of certain amino acids, as, for example, HMD-105-B-78 (Table I) which contained 56% proline and HMD-106-B-79 which was distinctively high in proline, phenylalanine, leucine, and isoleucine. These factors would also furnish a basis for differing biological effects.

Methods Used in Plant Tests

The parent acid, 2-(2,4-DP), and derivatized protein hydrolyzates were evaluated for plant growth-regulating activity using the dicotyledonous plants, Pinto bean, large seeded sunflower, Arlington White Spine cucumber, and the monocotyledonous plants Wong barley and U. S.-13 hybrid corn. The lanolin-assay method was used on the dicots and the coated sand-assay method was used on the monocots (5).

The degree of growth modification

induced by each derivative was estimated and scored according to intensity at intervals of 2, 4, 7, and 14 days following treatment. The responses observed 14 days after treatment are shown in Table III. Scores for the other intervals have been omitted to save space. Responses studied were stem curvature, growth inhibition, epinasty, formative effects, and induced cell proliferation (gall formation). The data are representative, although they do not show the rate of response or relative progressive effectiveness of the compounds tested.

Results of Plant Screening

Coupling of protein hydrolyzates with 2-(2,4-DP) gave products which, in general, induced plant-growth responses. With but few exceptions the magnitude of response of bean, sunflower, and barley to all derivatives was less than it was to the parent acid. Cucumber and corn showed a higher response to the derivatives. In about one third of the test plants observed the magnitude of response was greater than to 2-(2,4-DP) (Table III).

There was no definite correlation between plant responses and the time of hydrolysis for proteins hydrolyzed by alkali.

A summary of each growth-regulating

activity with respect to magnitude of response follows, to point out individual product and plant differences.

Stem Curvature. Cucumber response to all derivatives of α -protein, animal blood 2-hour and 8-hour, casein 4-hour and 8-hour, all meat and bone meal, and wheat gluten HMD-105-B-78 was greater than to the parent acid. Bean and sunflower responses were less to all hydrolyzate derivatives than to the parent acid. Barley response was also less with one exception. With the chicken feather 8-hour hydrolyzate product the response was equal to that produced by 2-(2,4-DP). The response of corn varied with the derivatives used. In nine cases it was less, in 15 cases equal to, and in the cases of meat and bone meal and in the vegetable protein (Dee-S) hydrolyzates it was greater than that of the parent acid.

Growth Inhibition. In general, all derivatives were more effective in inhibiting the growth of corn than the parent regulating compound; hence there was a marked increase in activity. This is a unique characteristic in striking contrast to the behavior of some individual D-, DL-, and L-amino acid derivatives of 2-(2,4-DP) previously evaluated (3). Only in the case of cucumber and the use of α -protein 4-hour, animal blood 2-hour, animal glue 4-hour, and wheat

gluten HMD-105-B-78 hydrolyzate derivatives were responses equal to that produced by the parent acid. All other products had less effect on the growth inhibition of bean, sunflower, cucumber, and barley than did 2-(2,4-DP).

Epinasty. Only on cucumber did hydrolyzate products induce a greater effect than did 2-(2,4-DP). Products affecting this response were those prepared from α -protein 4-hour, meat and bone meal 4-hour, and wheat gluten HMD-105-B-78 hydrolyzates. A few products did induce an equal response in some plants, but the majority induced less response.

Formative Effects. No hydrolyzate products induced formative effects exceeding those of the parent acid. The hydrolyzates produced less formative effects than did the parent acid in the case of cucumber.

Cell Proliferation at the First Internode. Three derivatives induced a slightly greater effect than 2-(2,4-DP). These were wheat gluten 5-SD acting on sunflower, and wheat gluten Luxor and HMD-105-B-78 acting on cucumber.

On the cucumber hypocotyl, nine products induced cell proliferation from slight to moderate as compared with the parent acid which induced none. These derivatives were the α -protein 2-hour and 8-hour, animal glue 2-hour and 4-hour, meat and bone meal 4-hour and 8-hour and the wheat gluten 5-SD and HMD-105-B-78 hydrolyzates. On the treated area only a slight to moderately increased cell proliferation was induced on cucumber by α -protein 2-hour and 4-hour hydrolyzates and by all the meat and bone meal hydrolyzates. There was less response to the majority of other derivatives than to the parent acid.

Acknowledgment

The authors acknowledge the advice and counsel of J. S. Ard of the Eastern Regional Research Laboratory in the preparation of this manuscript.

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Received for review April 30, 1959. Accepted August 4, 1959. Mention of commercial products or company names does not imply endorsement by the U. S. Department of Agriculture over others not named.